CLAIMS

1. An acoustic wave sensor comprising:

an acoustic wave cavity formed in a noncylindrical substrate and defined by an area having a mass per surface area that is greater than the mass per surface area of the substrate adjacent to the acoustic wave cavity; and

at least one transducer positioned with respect to the acoustic wave cavity to generate a torsional acoustic wave in the acoustic wave cavity.

2. An acoustic wave sensor as recited in claim 1 wherein the area of greater mass defining the acoustic wave cavity includes a raised area on the substrate.

3. An acoustic wave sensor as recited in claim 2 wherein the raised area has a circular periphery.

4. An acoustic wave sensor as recited in claim 2 wherein the raised area is a dome.

5. An acoustic wave sensor as recited in claim 4 wherein the dome is a truncated dome.

6. An acoustic wave sensor as recited in claim 2 wherein the raised area is integral with the substrate.

7. An acoustic wave sensor as recited in claim 2 wherein the raised area is bonded to the substrate.

8. An acoustic wave sensor as recited in claim 1 wherein the noncylindrical substrate is planar in the area of the acoustic wave cavity and the area immediately adjacent thereto.

9. An acoustic wave sensor as recited in claim 1 wherein the noncylindrical substrate is generally planar.

10. An acoustic wave sensor as recited in claim 1 wherein the sensor includes a piezoelectric transducer mounted on a surface of the acoustic wave cavity.

11. An acoustic wave sensor as recited in claim 1 wherein the sensor includes a plurality of piezoelectric transducers.

12. An acoustic wave sensor as recited in claim 11 wherein transducers mounted on opposite sides of the substrate have opposite polarities.

13. An acoustic wave sensor as recited in claim 1 wherein the sensor includes an electro-magnetic acoustic transducer adjacent a surface of the acoustic wave.

14. An acoustic wave sensor as recited in claim 1 wherein the sensor includes a plurality of electro-magnetic acoustic transducers.

15. An acoustic wave sensor as recited in claim 1 wherein the transducer is positioned off-center with respect to a centerline of the acoustic wave cavity and spaced inwardly from a peripheral edge of the cavity.

16. An acoustic wave sensor as recited in claim 1 wherein the transducer is positioned at a distance from a centerline of the acoustic wave cavity of approximately 0.6 to 0.8 times the distance from the center of the cavity to a peripheral edge of the cavity.

17. An acoustic wave sensor comprising:

an acoustic wave cavity formed in a noncylindrical substrate and defined by an area with a generally circular peripheral edge and having a mass per surface area that is greater than the mass per surface area of the substrate adjacent to the acoustic wave cavity; and

at least one transducer generating an acoustic wave substantially trapped in the acoustic wave cavity, the transducer being positioned off-center with respect to a centerline of the acoustic wave cavity.

18. An acoustic wave sensor as recited in claim 17 wherein the transducer is positioned at a distance from the center of the acoustic wave cavity of approximately 0.6 to 0.8 times the distance from the centerline of the cavity to a peripheral edge of the cavity.

19. An acoustic wave sensor as recited in claim 17 wherein the noncylindrical substrate is planar in the area of the acoustic wave cavity and the area immediately adjacent thereto.

20. An acoustic wave sensor as recited in claim 17 wherein the noncylindrical substrate is generally planar.

21. An acoustic wave sensor as recited in claim 17 wherein the sensor includes a piezoelectric transducer mounted on a surface of the acoustic wave cavity.

22. An acoustic wave sensor as recited in claim 17 wherein the sensor includes a plurality of piezoelectric transducers.

23. An acoustic wave sensor as recited in claim 22 wherein transducers mounted on opposite sides of the substrate have opposite polarities.

24. An acoustic wave sensor as recited in claim 17 wherein the sensor includes an electro-magnetic acoustic transducer adjacent a surface of the acoustic wave.

25. An acoustic wave sensor as recited in claim 17 wherein the sensor includes a plurality of electro-magnetic acoustic transducers.

26. An acoustic wave sensor comprising:

an acoustic wave cavity formed in a noncylindrical substrate and defined by a raised area with a generally circular peripheral edge; and

at least one transducer generating an acoustic wave substantially trapped in the acoustic wave cavity, the transducer being positioned off-center with respect to a centerline of the acoustic wave cavity.

27. An acoustic wave sensor as recited in claim 26 wherein the transducer is positioned at a distance from the centerline of the acoustic wave cavity of approximately 0.6 to 0.8 times the distance from the centerline of the cavity to a peripheral edge of the cavity.

28. An acoustic wave sensor as recited in claim 26 wherein the raised area is a dome.

29. An acoustic wave sensor as recited in claim 28 wherein the dome is a truncated dome.

30. An acoustic wave sensor as recited in claim 26 wherein the raised area is integral with the substrate.

31. An acoustic wave sensor as recited in claim 26 wherein the raised area is bonded to the substrate.

32. An acoustic wave sensor as recited in claim 26 wherein the sensor includes a piezoelectric transducer mounted on a surface of the acoustic wave cavity.

33. An acoustic wave sensor as recited in claim 26 wherein the sensor includes a plurality of piezoelectric transducers.

34. An acoustic wave sensor comprising:

an acoustic wave cavity formed in a noncylindrical substrate and defined by a raised area with a generally circular peripheral edge; and

at least one transducer generating an torsional acoustic wave substantially trapped in the acoustic wave cavity, the transducer being positioned off-center with respect to a centerline of the acoustic wave cavity.

35. An acoustic wave sensor as recited in claim 34 wherein the transducer is positioned at a distance from the centerline of the acoustic wave cavity of approximately 0.6 to 0.8 times the distance from the centerline of the cavity to a peripheral edge of the cavity.

36. An acoustic wave sensor comprising:

an acoustic wave cavity formed in a noncylindrical substrate and defined by an area with a generally circular peripheral edge and having a mass per surface area that is greater than the mass per surface area of the substrate adjacent to the acoustic wave cavity; and

at least one transducer generating an torsional acoustic wave substantially trapped in the acoustic wave cavity, the transducer being positioned off-center with respect to a centerline acoustic wave cavity.

37. An acoustic wave sensor as recited in claim 36 wherein the transducer is positioned at a distance from the centerline of the acoustic wave cavity of approximately 0.6 to 0.8 times the distance from the centerline of the cavity to a peripheral edge of the cavity.

38. An acoustic wave sensor comprising:

an acoustic wave cavity formed in a noncylindrical substrate and defined by an area having a mass per surface area that is greater than the mass per surface area of the substrate adjacent to the acoustic wave cavity; and

at least one transducer generating an acoustic wave that is substantially trapped in the acoustic wave cavity and that is insensitive to water of varying levels on the acoustic wave cavity.

39. An acoustic wave sensor as recited in claim 38 wherein the acoustic wave is a torsional wave.

40. An acoustic wave sensor as recited in claim 38 wherein the transducer is positioned off-center with respect to a centerline of the acoustic wave cavity and spaced inwardly from a peripheral edge of the cavity.

41. An acoustic wave sensor as recited in claim 38 wherein the transducer is positioned at a distance from the centerline of the acoustic wave cavity of approximately 0.6 to 0.8 times the distance from the centerline of the cavity to a peripheral edge of the cavity.

42. An acoustic wave sensor as recited in claim 38 wherein the trapped acoustic wave is sensitive to a finger touch on a surface of the acoustic wave cavity.

43. An acoustic wave sensor comprising:

an acoustic wave cavity formed in a substrate and defined by an area having an increased mass, the acoustic wave cavity having a first surface and a second surface opposite the first surface, at least one of said first and second surfaces being generally planar; and

at least one transducer positioned adjacent the first or the second surface of the acoustic wave cavity to generate a torsional acoustic wave in the acoustic wave cavity.

44. An acoustic wave sensor as recited in claim 43 wherein the area of increased mass is a raised area.

45. An acoustic wave sensor as recited in claim 43 wherein the transducer is mounted on the first or second surface of the acoustic wave cavity.

46. An acoustic wave sensor as recited in claim 43 wherein the transducer is an electro-magnetic acoustic transducer.

47. An acoustic wave sensor comprising:

an acoustic wave cavity formed in a substrate and defined by an area having an increased mass with a generally circular peripheral edge, the acoustic wave cavity having a first surface and a second surface opposite the first surface, at least one of said first and second surfaces being generally planar; and

at least one transducer positioned adjacent the first or second surface of the acoustic wave cavity for generating an acoustic wave substantially trapped in the acoustic wave cavity and wherein the center of the transducer is positioned off-center with respect to a centerline of the acoustic wave cavity and a distance inward from an edge of the acoustic wave cavity.

48. An acoustic wave sensor as recited in claim 47 where the area of increased mass is a raised area.

49. An acoustic wave sensor as recited in claim 47 wherein the transducer is mounted on the first or second surface of the acoustic wave cavity.

50. An acoustic wave sensor as recited in claim 47 wherein the transducer is an electro-magnetic acoustic transducer.

51. An acoustic wave sensor comprising:

an acoustic wave cavity formed in a substrate and defined by a raised area with a generally circular peripheral edge, the acoustic wave cavity having a first surface on the raised area and a second surface opposite the first surface, at least one of the first and second surfaces being generally planar; and

at least one transducer positioned adjacent the first or second surface of the acoustic wave cavity but off-center with respect to a

centerline of the acoustic wave cavity for generating an acoustic wave substantially trapped in the acoustic wave cavity.

52. An acoustic wave sensor as recited in claim 51 wherein the transducer is positioned at a distance from the centerline of the acoustic wave cavity of approximately 0.6 to 0.8 times the distance from the centerline of the cavity to a peripheral edge of the cavity.

53. An acoustic wave sensor as recited in claim 51 wherein the transducer is mounted on the first or second surface of the acoustic wave cavity.

54. An acoustic wave sensor as recited in claim 51 wherein the transducer is an electro-magnetic acoustic transducer.

55. An acoustic wave sensor comprising:

an acoustic wave cavity formed in a substrate and defined by a raised area with a generally circular peripheral edge, the acoustic wave cavity having a first surface on the raised area and a second surface opposite the first surface, at least one of the first and second surfaced being generally planar; and

at least one transducer positioned adjacent the first or second surface of the acoustic wave cavity but off-center with respect to a centerline of the acoustic wave cavity for generating a torsional acoustic wave substantially trapped in the acoustic wave cavity.

56. An acoustic wave sensor comprising:

an acoustic wave cavity formed in a substrate and defined by an area having an increased mass, the acoustic wave cavity having a first

surface and a second surface opposite the first surface, at least one of said first and second surfaces being generally planar; and

at least one transducer positioned adjacent the first or second surface of the acoustic wave cavity for generating an acoustic wave that is substantially trapped in the acoustic wave cavity and that is insensitive to water of varying levels on the acoustic wave cavity.

57. An acoustic wave sensor comprising:

an acoustic wave cavity formed in a substrate and defined by an area having an increased mass, the acoustic wave cavity having a first surface and a second surface opposite the first surface, at least one of said first and second surfaces being generally planar; and

at least one transducer positioned adjacent the first or second surface of the acoustic wave cavity at a distance from a centerline of the cavity of approximately 0.6 to 0.8 times the distance from the centerline of the cavity to a peripheral edge of the cavity.

58. An acoustic wave sensor comprising:

an acoustic wave cavity formed in a substrate and defined by an area of increased mass with a generally circular peripheral edge;

at least one transducer mounted on a surface of the acoustic wave cavity such that the length of the transducer is at an angle with respect to a radius of the acoustic wave cavity for generating an acoustic wave in the acoustic wave cavity.

59. An acoustic wave sensor comprising:

an acoustic wave cavity formed in a substrate and defined by an area of increased mass with a generally circular peripheral edge;

at least one transducer mounted on a surface of the acoustic wave cavity such that the length of the transducer is at a right angle with

respect to a radius of the acoustic wave cavity for generating an acoustic wave in the acoustic wave cavity.

60. An acoustic wave resonator comprising:

an acoustic wave cavity formed in a substrate and defined by an area of increased mass, the acoustic wave cavity having a first surface and a second surface opposite the first surface, at least one of said first and second surfaces being generally planar; and

at least one electro-magnetic acoustic transducer positioned adjacent the first or second surface of the acoustic wave cavity for generating an acoustic wave in the acoustic wave cavity, the transducer having a coil off-center with respect to the centerline of the acoustic wave cavity, the coil lying in a plane parallel to a planar surface of the acoustic wave cavity.

61. An acoustic wave resonator comprising:

an acoustic wave cavity formed in a noncylindrical substrate and defined by an area having a mass per surface area that is greater than the mass per surface area of the substrate adjacent to the acoustic wave cavity; and

at least one transducer positioned with respect to the acoustic wave cavity to generate a resonant torsional acoustic wave in the acoustic wave cavity.

62. An acoustic wave resonator comprising:

an acoustic wave cavity formed in a substrate and defined by an area of increased mass, the acoustic wave cavity having a first surface and a second surface opposite the first surface, at least one of said first and second surfaces being generally planar; and

at least one transducer positioned adjacent the first or second surface of the acoustic wave cavity for generating a resonant torsional acoustic wave in the acoustic wave cavity.

63. An acoustic wave resonator as recited in claim 62 wherein the acoustic wave cavity has a radius and the transducer is mounted on the acoustic wave cavity as at a distance from a centerline of the cavity such that the length of the transducer is perpendicular to the radius of the cavity.

64. An acoustic wave resonator comprising:

an acoustic wave cavity formed in a substrate and defined by an area of increased mass, the acoustic wave cavity having a first surface and a second surface opposite the first surface, at least one of the first and second surfaces being generally planar; and

at least one transducer mounted on the first or second surface of the acoustic wave cavity at a distance from a centerline of the cavity such that the length of the transducer is not parallel to an edge of the acoustic wave cavity.